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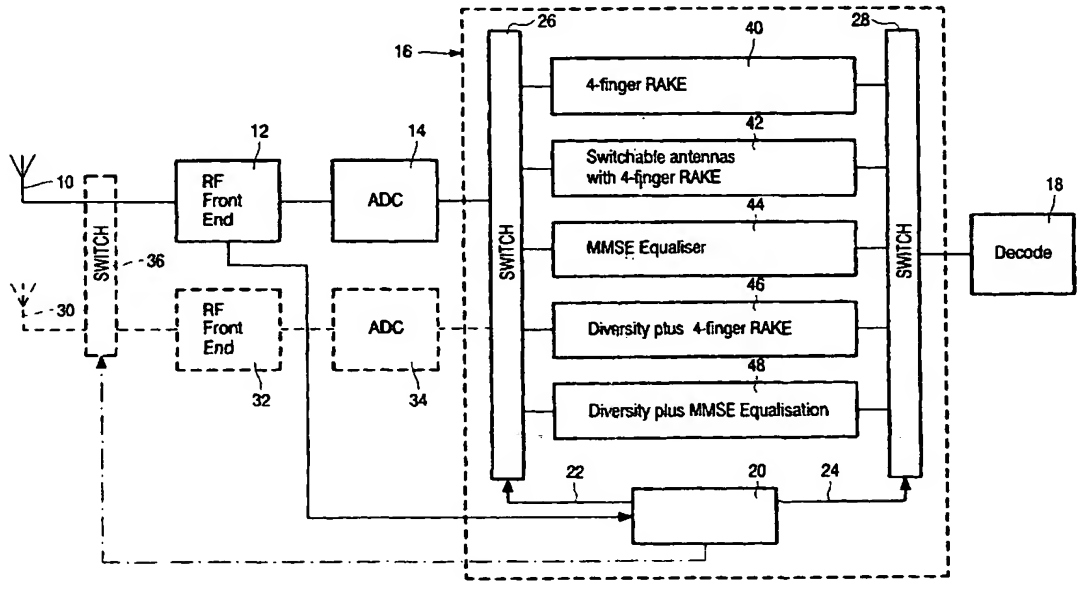
(54) Title: IMPROVEMENTS IN OR RELATING TO WIRELESS RADIO RECEIVERS



(57) Abstract: A wireless radio receiver, such as a cellular telephone, having a stage (16) for processing a received radio signal in accordance with one of several alternative algorithms (40 to 48) selected as a consequence of monitoring the signal propagation environment. The algorithms offer a trade-off between the degree of signal processing and current consumption.

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DESCRIPTION

IMPROVEMENTS IN OR RELATING TO WIRELESS RADIO RECEIVERS

The present invention relates to wireless radio receivers having particular, but not exclusive, application to receivers operating in accordance with third generation cellular telephone standards (3G or UMTS). The present invention may also be applied to handheld radio devices, for example mobile phones operating in accordance with GSM, IS95, wireless local area networks (LANS) such as those operating in accordance with IEEE 802.11 standard, digital cordless phones, for example DECT phones, and private mobile radio devices.

Different propagation environments require different degrees of processing within a radio receiver in order to obtain an acceptable performance. The more unfriendly the environment the more rigorous processing is required in the receiver to demodulate the received signal correctly. However the more processing that is required the higher the power consumption of the radio. Techniques which give an optimum performance generally require a large amount of processing and which technique is the most suitable can vary depending on the situation that the radio is in.

Recent improvements in processor speeds and efficient implementations of large Field Programmable Gate Arrays (FPGAs) has meant that flexibility and adaptability of radio receivers has become more and more possible with a receiver able to reconfigure itself within ever decreasing lengths of time.

User expectations of the length of time a battery powered device will last without a recharge is increasing due to the improvements that have been made in power consumption of semiconductor devices over time resulting in mobiles having in excess of 200 minutes talk time. This has come about primarily due to more efficient integrated circuits (ICs) with lower supply

voltages. The degree to which the efficiency of ICs can keep up with this demand for longer talk times is becoming less possible and other methods of improving battery performance are required.

The abstract of Japanese Published patent Application No. 2000-236293 discloses varying the power required for voice processing in a battery powered receiver by monitoring the received field strength and the detected data error rate and using the results to control the speed of voice processing.

Adaptive equalisers have been studied widely to enable a receiver to change its characteristic according to its operating environment. These, however, still rely on using the same algorithm at all times and just adapting the weights of the taps to adjust the performance or in the extreme turning the equaliser fully off.

US Patent Specification US 2001/0036222 discloses a mobile radio telephone receiver having a RAKE receiver portion in which the power consumption in one or more RAKE fingers is reduced selectively in consideration of one or more estimated path parameters. More particularly, the power consumption of the RAKE receiver portion can be adapted to the instantaneous state of the mobile radio channel and thereby minimised. The power consumption in a RAKE receiver can be reduced by reducing its processing rate or disconnecting a finger. One method by which the RAKE finger selection and power consumption device cuts off a RAKE finger is when the estimated path energy of the path allocated to this RAKE finger is less than a threshold value that is a function of a mean value of the estimated path energies and a variance of the estimated path energies. A characteristic of this cited receiver is that the power consumption saving is dependent on criteria decided by the equipment manufacturer rather than only by the operating environment which can exhibit difficulties for a radio receiver trying to detect accurately the required signals. Examples of difficult operating environments are heavily multipath environments and those with large numbers of other radio signals which interfere with the wanted signal.

An object of the present invention is to enable a wireless radio device to be able to reconfigure itself to a current radio environment and in so doing to be able to optimise on the use of power and performance.

According to one aspect of the present invention there is provided a method of operating a wireless radio receiver, the method comprising monitoring the propagation environment and configuring the processing of a received signal in accordance with one of at least two predetermined signal processing algorithms selected in response to the nature of the monitored propagation environment.

According to a second aspect of the present invention there is provided a wireless radio receiver comprising means for monitoring the propagation environment, means for producing at least two signal processing algorithms, and means responsive to the nature of the monitored propagation environment for selecting the production of one of the at least two signal processing algorithms and for processing the received signal accordingly.

The present invention is based on the concept that a receiver selects the algorithm to be used in processing a received signal to suit the current propagation environment and in so doing optimises the battery power consumption whilst maintaining an acceptable receiver performance

The architecture of the device will determine how the method in accordance with the present invention can be implemented. For example a RAKE radio receiver may be able to demodulate accurately a desired signal in a multipath environment but when there are a number of other users also present in say a wireless channel it cannot deal with the multiple access interference produced by cross correlations with these other users' signals. However the receiver performance can be improved by reconfiguring the receiver to become an equaliser.

The present invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is a block schematic diagram of a receiver (or receiver section) of a battery powered radio device, and

Figure 2 is a flow chart illustrating an implementation of the method in accordance with the present invention,

In the drawings the same reference numerals indicate corresponding features.

Referring to Figure 1, the mobile radio device comprises an antenna 10 coupled to a RF front end 12 which produces a base band signal which is digitised in an analog-to-digital converter (ADC) 14. A signal processing stage 16, which provides in the present example five preselected signal processing algorithms for operating on the digitised signal, is coupled to an output of the ADC 14. A decoding stage 18 is coupled to an output of the signal processing stage 16.

The RF front end 12 is also coupled to a circuit 20 for monitoring the radio propagation environment. The circuit monitors one or more characteristics selected from RSSI (radio signal strength indicator), CRCs within the signal, pilot signals, pilot bits within a received signal, for example the CPICH channel for UMTS, or a synchronisation sequence, for example the sync. code word for Bluetooth, Registered Trade Mark, or for DECT. In a variant tap weights of an adaptive equaliser may be monitored to provide an indication of the quality of the signal channel.

The monitoring circuit 20 includes a processor (not shown) which has outputs 22, 24 for controlling switches 26,28 for selecting one of five signal processing algorithms in response to the results of monitoring the signal propagation environment.

In order to be able to include signal diversity as an option in the signal processing algorithms, a second RF path shown in broken lines is provided. The second path comprises an antenna 30 coupled to a RF front end 32 which in turn is coupled to an ADC 34. An output of the ADC 34 is coupled to an input of the signal processing stage 16. A switch 36 controlled by the circuit 20 is provided to select one or other of the antennas 10, 30 or if required both of the antennas.

The signal processing stage 16 is able to generate five different signal processing algorithms which for convenience of illustration are represented by five parallel arranged blocks 40, 42, 44 46 and 48 coupled between outputs of the switch 26 and the inputs of the switch 28. The algorithms comprise (1) a 4 finger Rake operation, block 40, (2) switchable antennas with 4 finger RAKE, block 42, (3) MMSE (Minimum - Mean - Square - Estimator) equaliser, block 44, (4) diversity plus 4 finger Rake operation, block 46, and (5) diversity plus MMSE equalisation, block 48. Power consumption progresses upwards from Algorithm (1) to Algorithm (5).

The method in accordance with the present invention will now be described reference to the flow chart shown in Figure 2.

Block 50 denotes the receiver being switched-on. Block 52 denotes the processing stage selecting a predetermined default one of the five algorithms (1) to (5) or the previously selected algorithm in the event of there not being a predetermined default algorithm. Block 54 denotes processing the received signal using the currently selected algorithm.

Block 56 denotes the signal propagation environment being monitored by the monitoring circuit 20 (Figure 1). Block 58 denotes checking that currently selected algorithm is the best suited to the propagation environment. If it is (Y), the flow chart reverts to the block 54. If it is not (N), then in block 60 a check is made if another algorithm should be selected. If the answer is No (N), the flow chart reverts to the block 54. If the answer is Yes (Y) then block 62 denotes the processing stage selecting another one of the five algorithms. The flow chart reverts to the block 54.

In another, non-illustrated, example of the method in accordance with the present invention, a receiver operating in a cellular environment in a built-up area with many buildings, that is heavily multipath, and using a radio channel having only a few other users on it may be configured to act as a 6 path RAKE receiver. If more users enter the same cell or the user moves to the edge of the cell so the receiver picks-up interference from not just the other users in its cell but also from those in the adjacent cell, the receiver on detecting this deterioration in the signal propagation environment reconfigures

its architecture to perform equalisation, and in so doing removes multiple access interference. If now the user moves from the urban area to a rural area not having many, if any, high buildings and very few other radio users being present, the radio in response to detecting this change in the radio propagation environment reconfigures itself to use only switchable antennas with a simple RAKE thereby minimising the drain on the batteries.

In the present specification and claims the word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. Further, the word "comprising" does not exclude the presence of other elements or steps than those listed.

From reading the present disclosure, other modifications will be apparent to persons skilled in the art. Such modifications may involve other features which are already known in the design, manufacture and use of wireless radio receivers and component parts therefor and which may be used instead of or in addition to features already described herein. Although claims have been formulated in this application to particular combinations of features, it should be understood that the scope of the disclosure of the present application also includes any novel feature or any novel combination of features disclosed herein either explicitly or implicitly or any generalisation thereof, whether or not it relates to the same invention as presently claimed in any claim and whether or not it mitigates any or all of the same technical problems as does the present invention. The applicants hereby give notice that new claims may be formulated to such features and/or combinations of such features during the prosecution of the present application or of any further application derived therefrom.

CLAIMS

1. A method of operating a wireless radio receiver, the method comprising monitoring the propagation environment and configuring the processing of a received signal in accordance with one of at least two predetermined signal processing algorithms selected in response to the nature of the monitored propagation environment.

2. A method as claimed in claim 1, characterised in that the at least two predetermined signal processing algorithms are selected from 4-finger Rake receiver, switchable antennas with 4-finger RAKE, MMSE (Minimum Mean Square Estimator) equaliser, antenna diversity plus 4 finger RAKE receiver and antenna diversity plus MMSE equalisation.

3. A wireless radio receiver comprising means (20) for monitoring the propagation environment, means (16) for producing at least two signal processing algorithms, and means responsive to the nature of the monitored propagation environment for selecting the production of one of the at least two signal processing algorithms and for processing the received signal accordingly.

4. A receiver as claimed in claim 3, characterised in that the algorithms produced by said means (20) include 4-finger Rake receiver, switchable antennas with 4-finger RAKE, MMSE (Minimum Mean Square Estimator) equaliser, antenna diversity plus 4 finger RAKE receiver and antenna diversity plus MMSE equalisation.

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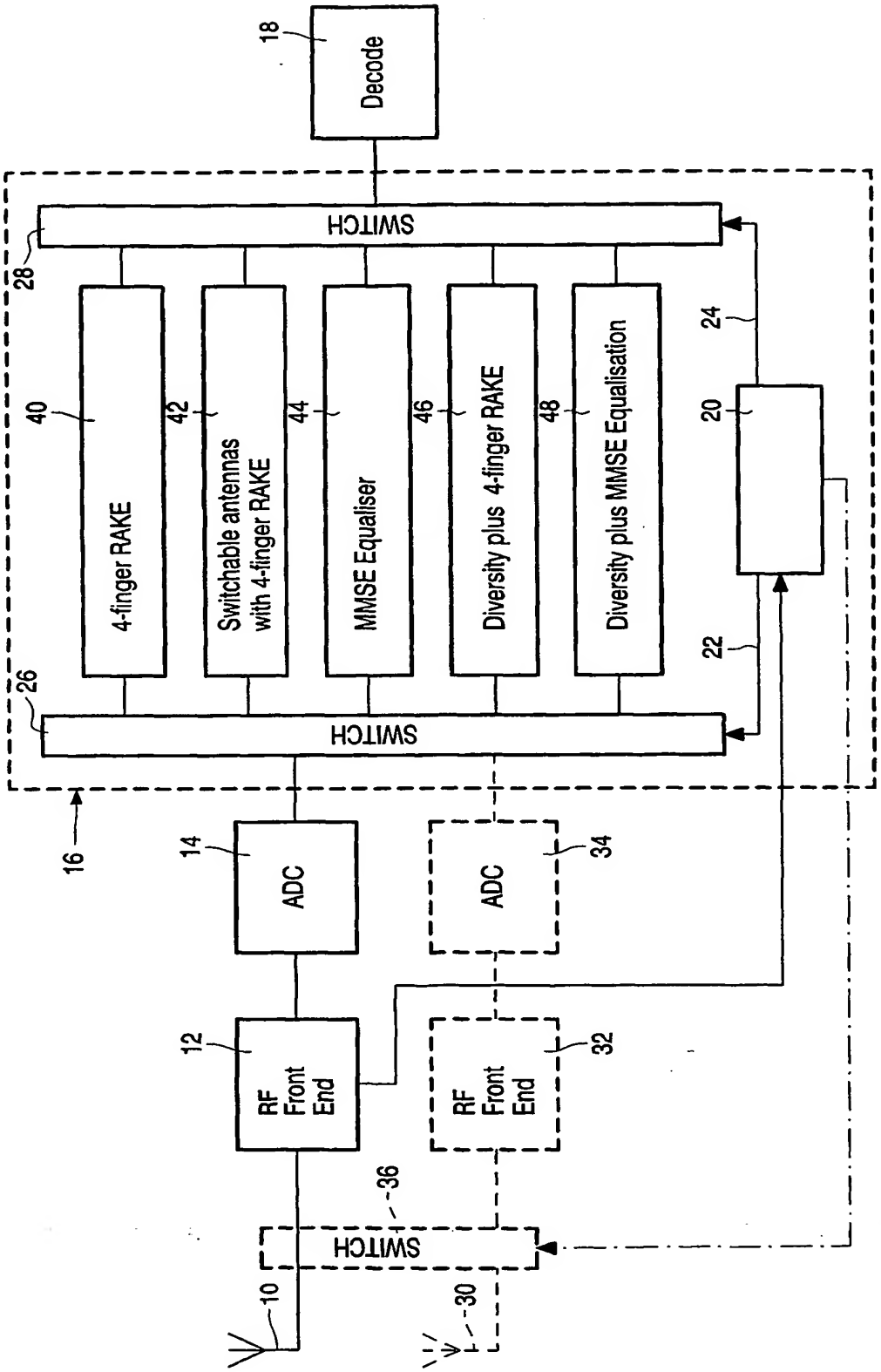
18
Decode
SWITCH
28
40
4-finger RAKE
42
Switchable antennas with 4-finger RAKE
44
MMSE Equaliser
46
Diversity plus 4-finger RAKE
48
Diversity plus MMSE Equalisation
24
20
22
26
SWITCH
16
14
ADC
34
ADC
12
RF Front End
32
RF Front End
36
SWITCH
10
30

FIG.1

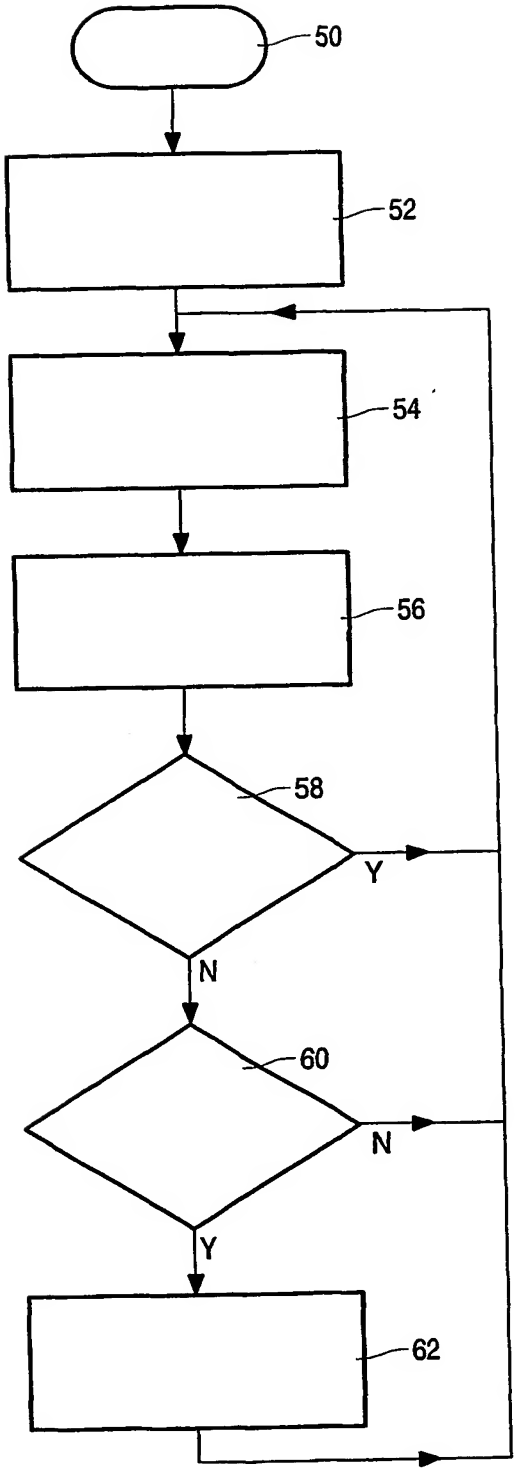

FIG.2

INTERNATIONAL SEARCH REPORT

PCT/IB 03/03495

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/32 H04B1/707

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LATVA-AHO M ET AL: "Reconfigurable adaptive RAKE receiver for wideband CDMA systems" VEHICULAR TECHNOLOGY CONFERENCE, 1998. VTC 98. 48TH IEEE OTTAWA, ONT., CANADA 18-21 MAY 1998, NEW YORK, NY, USA,IEEE, US, 18 May 1998 (1998-05-18), pages 1740-1744, XP010288219 ISBN: 0-7803-4320-4	1,3
Y	abstract paragraphs IV. and V. ---	2,4
X	GB 2 371 725 A (UBINETICS LTD) 31 July 2002 (2002-07-31)	1,3
Y	page 6, line 5 -page 7, line 19 figure 3 ---	2,4
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 October 2003	02/12/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Rabe, M

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 428 664 A (KOBAYASHI TAKEO) 27 June 1995 (1995-06-27) column 1, line 46 - line 64 column 2, line 51 -column 3, line 25 figure 2	1-4
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		NO 20004314 A	30-08-2000